IMPROVING THE EARTHQUAKE CHRONOLOGY FOR THE ST. LOUIS REGION: COLLABORATIVE RESEARCH (M. TUTTLE & ASSOCIATES AND U.S. GEOLOGICAL SURVEY)

Annual Project Summary

USGS External Grant Award No. 05HQGR0045

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NEHRP Element: I (National and Regional Earthquake Hazard Assessments) and III (Research on Earthquake Physics, Occurrence, and Effects)

Key Words: Paleoliquefaction, Age Dating, Recurrence Intervals

Investigations Undertaken

Despite recent paleoseismology studies, significant uncertainties remain regarding the timing, source areas, magnitudes, and recurrence intervals of large paleoearthquakes in the St. Louis region. This project aims to reduce those uncertainties by conducting reconnaissance for and investigations of liquefaction features along several rivers in the surrounding region, to relocate sites of 1811-1812 liquefaction near Cahokia, Illinois, and to reanalyze liquefaction data across the region. By further constraining the temporal, spatial, and size characteristics of prehistoric earthquakes in the central U.S., this project will improve seismic hazard assessments as well as regional and national hazard maps, and hopefully reduce losses from future earthquakes.

During the project period from January 1 to September 30, 2005, we began research on an historical account of liquefaction near St. Louis during the 1811-1812 New Madrid earthquakes. Our hope is to relocate historical sites of liquefaction in order to compare them with other liquefaction sites found in the St. Louis region (Tuttle, 2005). In addition, we resurveyed the Cache River in southern Illinois to relocate previously documented liquefaction features and to collect additional samples for radiocarbon dating. We also surveyed the Clarks and Tennessee Rivers in northwestern Kentucky to further characterize the distribution of liquefaction features in the region.

Additional fieldwork is planned for the fall of 2005. Once the field season is over, samples will be reviewed and selected samples submitted to Beta Analytic for radiocarbon dating. Sediment samples collected for optically stimulated luminescence (OSL) dating will be sent to and analyzed by Shannon Mahan at the U.S. Geological Survey. This project is being conducted by Martitia Tuttle, Kathleen Dyer-Williams, and Caroline Moseley of M. Tuttle & Associates in collaboration with Eugene Schweig, Richard Dart, and Natasha McCallister of the U.S. Geological Survey.

Results of Investigations

Account of Liquefaction Near St. Louis in 1811-1812

Several years ago, Ron Street provided the Principal Investigator, Martitia Tuttle, with several historical accounts of ground failure in Illinois during the 1811-1812 New Madrid earthquakes. One of those accounts describes ground failure typical of earthquake-induced liquefaction:

"An almost continual earthquake, which lasted from the night of the 15-16 of December until now, February 19, helped much to bring people back [to their religion]. A great many houses have been badly damaged, but no one was killed. The earth opened in many places, especially about three miles from our monastery. Only sand and water came from the opening. Fortunately, our poor cabins of wood and sand can withstand a great deal of shaking without much danger….Some stone and brick houses have had to be abandoned."

The account comes from a letter written by Dom Urban Guillet on February 18, 1812 to the Bishop Pleiss of Quebec (McDermott, 1949). Father J. P. Donnelly translated and edited this letter and

other correspondence between Guillet and Pleiss. Dom Urban Guillet was a Trappist monk living adjacent to Monks Mound, a large earthen mound constructed by Native Americans between A.D. 900-1150 and now part of the Cahokia Mounds State Historic Park near Collinsville, Illinois. According to McDermott (1949), the Trappist monks lived at Monks Mound from about 1809 to 1813. We have requested a copy of the original letter describing earthquake-related ground failure from the Archive of the Archdiocese of Quebec for the purpose of verifying Donnelly's translation. Our interpretation of the account is that the 1811-1812 New Madrid earthquakes induced liquefaction in the Mississippi River floodplain east of St. Louis and that conspicuous sand blow deposits formed about three miles from Monks Mound.

We have begun the process of trying to relocate sand blows described in Dom Urban Guillet's letter. As part of this process, we have conducted a preliminary search of online and published sources for early aerial photography of the Monks Mound area. A partial list follows:

1. Aerial photographs (oblique) of Cahokia Mounds taken in 1922 by Lt. George W. Goddard and Lt. H. K. Ramsey of the U.S. Army Air Service. Originals are held by the Illinois State Museum.
2. Aerial photographs (vertical) of Cahokia Mounds taken in 1933 by Lt. Dache Reeves of the U.S. Army Air Service. Original negatives at the Smithsonian Institution; copy prints at University of Wisconsin-Milwaukee Archaeological Research Laboratory.
3. High-resolution digital images of aerial photography of Cahokia Mounds/Collinsville area taken in 1939-1941 by the U.S. Department of Agriculture's Agricultural Adjustment Administration. Available from the Illinois Historical Aerial Photography Project, Illinois Natural Resources Geospatial Data Clearinghouse.

In the near future, we will either download or otherwise acquire these and other aerial photographs of the Cahokia Mound area and examine them for surficial features suggestive of sand blow deposits. Once possible sand blows are identified, we will follow up with site investigations.

River Reconnaissance and Earthquake-Induced Liquefaction Features

Cache River in southern Illinois

In September, we resurveyed 4 km of the Cache River northeast of Karnack, Illinois, where liquefaction features had been found during a previous study (Tuttle et al., 1999). The river level was slightly lower than it had been during the previous survey. We relocated sand dikes at site CR10 and collected new samples for radiocarbon dating. We also relocated site CR8 but most of the liquefaction features had been removed by erosion with the exception of an iron-stained sand sill. An organic sample for radiocarbon dating was collected from the mottled silt about 20 cm above the sand sill. We found a new liquefaction site, CR12, about 12 m upstream from CR10. Several other sites were not relocated because they were either covered by silt (PC2 and PC6) or grown over by vegetation (PC1 and C11).

At CR12, mottled silt overlies massive fine to medium sand and crossed-bedded, medium to pebbly sand (Figure 1). Sand sills occur along the contact between the mottled silt and underlying sand and seven small (0.5-3 cm in width) sand dikes extend from the sills 5-15 cm

into the overlying silt. Disturbance of bedding in the sand deposit and foundering of clasts of the overlying silt into the sand deposit suggest *in situ* liquefaction. We searched for but could not find material for radiocarbon dating. However, the sample collected from nearby site CR8 will help to establish a maximum age constraint for liquefaction features at these two sites.

Tennessee River in northwestern Kentucky

We conducted reconnaissance along 24 km of the Tennessee Rivers downstream from Kentucky Lake, Kentucky. Exposure was excellent and almost continuous along both banks of the river. We searched many long stretches of riverbank on foot in order to closely examine the exposures. Cutbanks ranged from 4-8 m in height and were composed of weathered silt overlying interbedded silt and sand. In a few locations, we observed cross-bedded sand below interbedded silt and sand. We found sand and silt dikes at three sites (TN2, TN4 and TN5) north of Calvert City.

At TN2, we found predominately silt-filled dikes that terminate about 3 m below the surface (or 1 m above the water level) within weathered silt. Two of the dikes are slightly wider (1-2 cm) than the others. At first, we thought these might be cracks into which silt had washed. However, after seeing sand-filled, as well as silt-filled dikes, at similar levels at other sites, we think that the silt dikes are probably related to earthquake-induced liquefaction. We collected two samples from the weathered silt and below the dike terminations for radiocarbon dating.

At TN4, we found one small (1 cm wide) sand dike. The dike is very weathered and terminates about 7 m below the surface (or 0.8 m above the water level) within weathered silt. We collected two samples, one close to the dike tip, for radiocarbon dating. At site TN1, located about 100 m downstream from TN4, we found an area of burned soil, large pieces of charcoal, and several burned angular rock fragments about 7 m below the surface. The burned area is likely to be a Native American hearth. We collected a large piece of charcoal from the burned area that may be helpful for establishing the maximum age of the nearby sand dike.

At TN5, we found a sand dike that is up to 7 cm wide and is weathered and bioturbated. This dike terminates about 4.7 m below the surface (or 0.3 m above the river level) within weathered silt with interbeds of silty sand. We collected four samples, one close to the dike tip, for radiocarbon dating. At this site and also along the bank about 220 m to the east, there are many silt-filled cracks up to 1.5 cm wide at a similar level as the sand dike.

Clarks River in northwestern Kentucky

We surveyed 5 km of Clarks River upstream of its confluence with the Tennessee River. Exposure was very good. Cutbanks typically ranged from 2-5 m high and were composed of brownish interbedded silt and sand overlying reddish mottled silt. Near the mouth of the river, cutbanks were only 1.5 m high and composed of predominantly of silt.

At one site (CKR1), we found sand dikes and a related sand blow exposed low in the bank, about 2.5 m below the surface (or 0.4 m above the water level) (Figure 2). Two sand dikes, 7.5 and 6 cm wide and only 18 cm apart, appear to have fed the sand blow. Two other smaller sand dikes

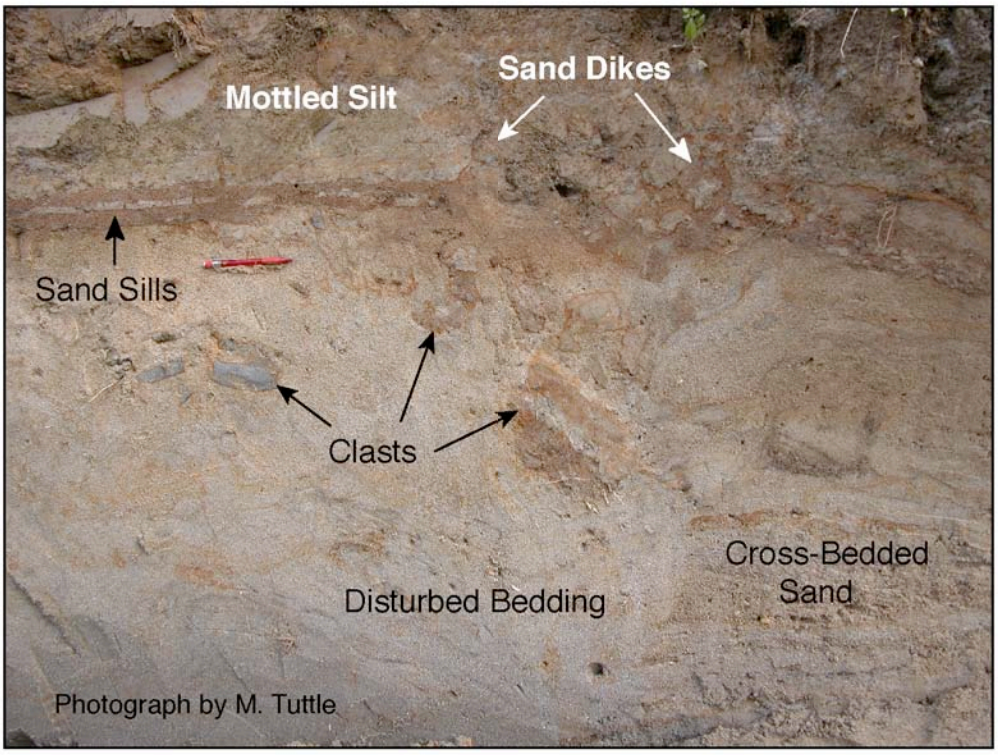

Figure 1. Photograph of earthquake-induced liquefaction features, including sand dikes and sills, at site CR12 along Cache River near Karnack, Illinois. For scale, red pencil is 5 cm long.

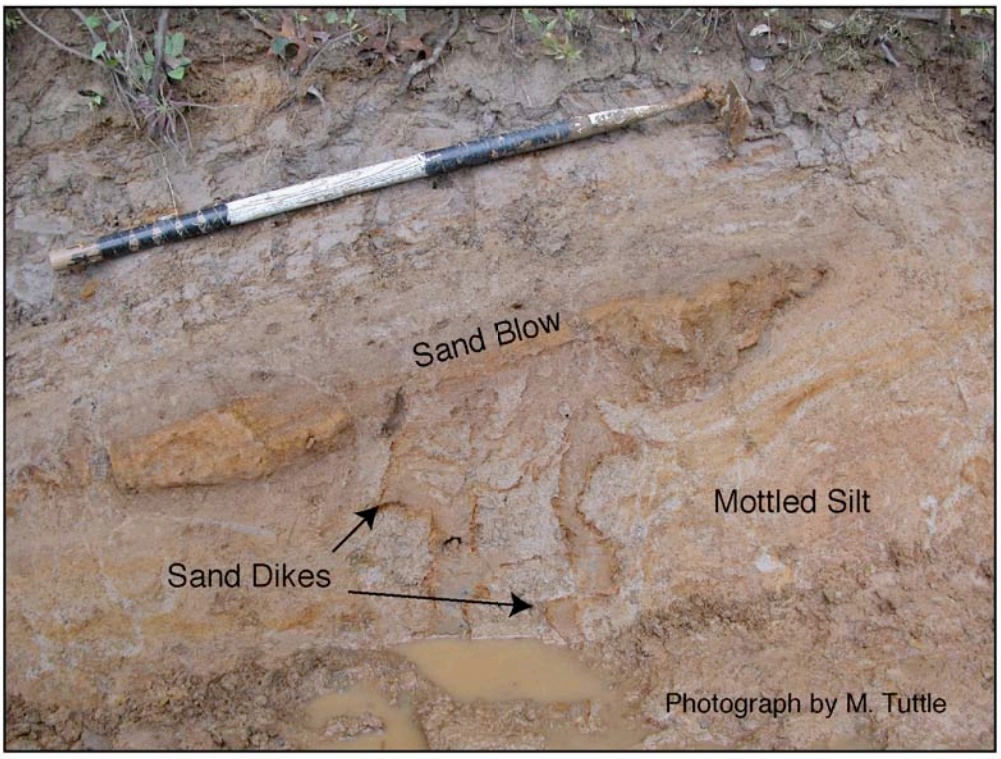

Figure 2. Photograph of weathered sand blow and related sand dikes at site CKR1 along Clarks River southeast of Paducah, Kentucky. For scale, hoe is 1 m long.

(2 and 1 cm wide) terminate below the sand blow. The sand blow is up to 18 cm thick and more than 2.4 m in length. It ranges in grain-size from small pebbles and granules to sandy silt. It fines upward and away from the dikes and contains clasts of silt. The sand blow is iron-stained and even cemented in places. The upper part of the sand blow may have been reworked. We collected samples above and below the sand blow for both radiocarbon and OSL dating.

References Cited and Recent Publications

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Contact Information and Data Availability

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Non-Technical Summary

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